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(54) Apparatus for dosing fibre cut into a concrete mixture.

(57) An apparatus for adding to a concrete mixture a desired quantity of fibre cut e.g. of plastic. The apparatus comprises a concrete mixer (5), at least one hopper (6a-d) for storing a supply (15) of fibre cut, a dosing mechanism (11, 14) for taking out for each mixing cycle the desired quantity of fibre cut from the said supply (15), a conveyor (8 ; 27) for conveying the fibre cut to the concrete mixer (5), and a smoothing device (19a-b ; 29) for distributing in the course thereof the quantity of fibre cut taken out evenly during the dry mixing. By the invention it is possible to obtain a far more even and more uniform distribution of plastic fibres in concrete than has been known before, whereby the material improving properties of the plastic fibres are optimally exploited.

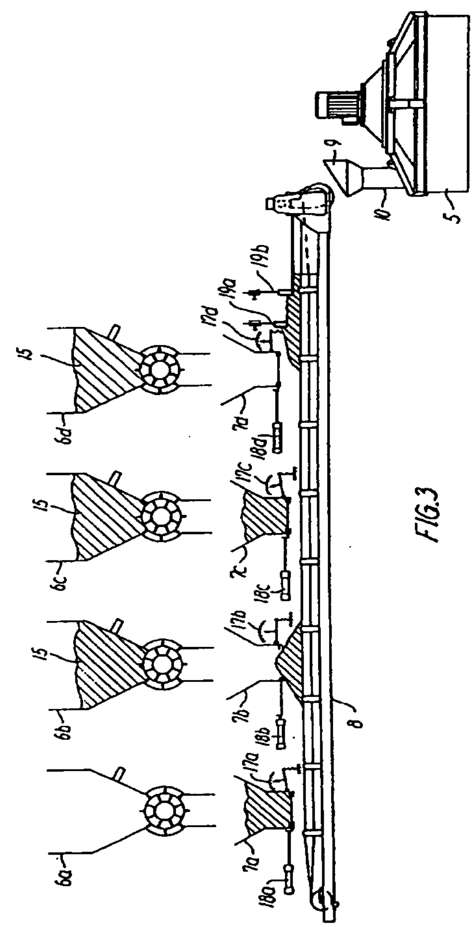

FIG.3

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The invention relates to an apparatus for adding to a concrete mixture a desired quantity fibre cut e.g. of plastic, and which comprises a concrete mixer, at least one hopper for storing a supply of fibre cut, a dosing mechanism for taking out for each mixing cycle the desired quantity of fibre cut from the said supply, a conveyor for conveying the fibre cut to the concrete mixer, as well as a smoothing device for distributing in the course thereof the quantity of fibre cut taken out evenly over a predetermined period of the mixing cycle.

Like reinforcing irons, fibres of various kinds have for many years advantageously been used for increasing the tensile strength of concrete. When the fibres are of plastic, e.g. polypropylene, there are additionally obtained other significant advantages.

In the low-dosing area, where 1-3 kg fibres/m^3 concrete are added, the plastic fibres thus prevent visible shrinkage cracks by limiting the development of micro-cracks. Especially during the first phase of the hardening, concrete normally undergoes a volume reduction causing formation of micro-cracks. The presence of the plastic fibres entails that this crack-formation is counteracted, and that the concrete develops its full potential strength and impermeability. The fibres change the intrinsic structure of the concrete, and a crack-free product is obtained which does not call for provision of traditional shrinkage reinforcement nets.

In the high-dosing area, where 10-20 kg fibres/m^3 cement bound material are added, the fibres additionally impart a decided reinforcing effect to the material, whereby its tensile strength, tenacity and energy of rupture are significantly increased. When the fibre reinforced object is loaded in excess of the bearing capacity of the unreinforced material, countless evenly distributed stable micro-cracks are formed, but the presence of the fibres entails that this crack-formation does not lead to fracture until at a significantly higher load.

The even distribution of the micro-cracks necessary for obtaining the above advantageous properties is, however, contingent on a correspondingly even distribution of the plastic fibres. These fibres, however, have very small density as compared with e.g. the aggregates stone and sand, and besides, the fibres take up negligible space in comparison with the total concrete mass. Consequently, it has been extremely difficult to achieve a sufficiently even distribution of the fibres by means of the previously used dosing method where the fibres were merely batchwise poured manually into the concrete mixture.

An improved distribution is obtained by the method disclosed in Swiss patent specification No. 460.620 where a continuous fibre string by a cutter is cut into suitable lengths which are add d to a concrete mixture during the mixing process.

From German Public Disclosure No. 3307341 is also known a method where fibre cuts, which are stored in a silo, are added to a concrete mixture during th mixing process. The fibre cut is placed on an inclined box shaped chute provided at its lower end with a rotatable brush for loosening the possibly tangled fibre cut mass.

It is, however, a common feature of these two known methods that they are unable to ensure a satisfactorily even distribution of the fibres in the mixture, since the quantity of fibres added during the wet mixing because of the water content tends to stick to the aggregates in the local area in which the fibre cut fell into the concrete mixture. Consequently, futher distribution to the rest of the concrete mixture will only be possible to a very limited extent.

It is the object of the invention to provide an apparatus of the kind described in the introduction, where the fibres are automatically distributed more evenly and uniformly in the concrete mixture than known before.

This is achieved by the novel and characteristic feature of the apparatus according to the invention where the predetermined period falls within the period of time in which the dry mixing takes place. This ensures that the fibres already during the dosing proper become evenly distributed in the material, since this material successively and with simultaneous mixing passes under the area or areas near the top of the concrete mixer, where the fibres are added, and that the fibres are not hereby bound by moisture to the aggregates, but on the contrary can move freely in relation thereto.

According to a particularly uncomplicated embodiment the apparatus is supplied with fibre cuts which have been premetered into portions suited for a mixing cycle. These portions are then placed in each separate hopper, the lowermost opening of which is usually closed by a gate. When dosing is about to take place, the said gate is merely opened, whereafter the fibre content of the respective hoppers falls down on an underlying conveyor conveying the fibre cut into the concrete mixer in an even and uniform flow, in the way it will be described in more detail below.

However, it is often cumbersome and involves additional costs to have to premeter the fibre cut into portions and stock portions of varying sizes for different mixtures.

According to a particularly preferred embodiment the apparatus is therefore adapted for being able to operate with fibre cut in whole bales or boxes, sufficing for many portions. Each hopper consequently has a size which can accomodate a whole bale or box, and at the bottom at the lower opening the hopper has a rotatable drum with outwardly projecting carriers in the form of pegs or vanes for by dosing taking out a prem tered fibre cut portion from the hopper, the drum hereby rotating exactly the numb r of times corresponding to th desired size of the portion.

As previously mentioned, this siz is rather small and it may therefore be difficult to meter so small a fibre cut portion with a drum provided with pegs or vanes along the entire axial extension of the drum, which for practical reasons must have a length corresponding to the dimensions of the bale. According to a modification of the above embodiment the drum is therefore only provided with carriers along a limited section of its axial extension. This entails that the carriers per revolution take out a comparatively smaller quantity of fibre cut from the hopper, so that the metering can be regulated more accurately. In order to gradually remove the entire content of fibre cut in the hopper, the drum is during the rotation simultaneously displaced slowly to and fro.

The bales, which may be rather large and heavy, rest partly with their weight on the drum, whereby the fibre cut may become somwehat inclined to pack around the drum and its carriers, which may therefore damage the fibres during the taking out, which furthermore only with difficulty can be performed with the required accuracy. In this case the drum may also along its surface be provided with a number of evenly distributed throughgoing openings, through which an air stream is blown during the taking out, which stream causes the fibres to remain around the drum in a loosely floating state, so that the fibres do not tend to pack. To improve this effect air may additionally be blown into the hopper through its sides.

The metered fibre cut portion is, as mentioned above, conveyed to the concrete mixer by means of a conveyor accomodated below the hoppers. According to one embodiment this conveyor may be a conveyor belt having one or more smoothing rakes at the discharge end for distributing the fibre cut along the belt surface into a suitably thin layer. During the travel of the belt the fibre cut will then be supplied to the concrete mixer in an even flow.

According to another embodiment the conveyor may be an air duct which during the dosing is blown through by an air stream conveying the fibre cut to the concrete mixer. For smoothing the fibre flow a rotatable sluice has in this case been interposed in the duct between the hoppers and the concrete mixer, which sluice the fibre cut must pass before arriving in the concrete mixer. This sluice comprises a drum having outwardly projecting vanes delimiting a number of sluice chambers, each of which is only capable of accomodating a limited quantity of fibre cut. During the rotation of the drum the fibre flow is then smoothed in dependence of the rotational speed and the volume of the sluice chambers. Also in this case the drum may along its surface be equipped with a number of evenly distributed throughgoing holes being blown through by an air stream in order to prevent the fibres from packing.

In the following the invention is explained in more detail by way of examples of embodiments, ref rence being made to the drawing in which

Fig. 1 shows a conventional apparatus for mixing concret ,

Fig. 2 shows a first embodiment of a dosing mechanism having a conveyor belt for supplying the apparatus shown in fig. 1 with a fibre cut portion which has just fallen down and lies in a heap on the belt,

Fig. 3 shows the same, but where the fibre heap has now been conveyed to smoothing rakes positioned at the discharge end of the belt for raking the heap into a suitably thin layer along the belt,

Fig. 4 shows schematically a front view of a rake,

Fig. 5 shows, in a larger scale, the fibre heap in the process of being smoothed into a thin layer by the smoothing rakes,

Fig. 6 shows a second embodiment of a dosing mechanism having an air duct for supplying by means of a blower the plant shown in fig. 1 with a fibre cut portion, which has just fallen down and lies in a heap in the duct,

Fig. 7 shows, in a larger scale, a smoothing sluice appertaining to the dosing mechanism shown in fig. 6 for dividing the fibre heap into an even flow of fibre cut,

Fig. 8 shows a cross-section of a hopper with a first embodiment of a rotatable drum with carriers for batch-wise taking out the fibres from the fibre supply in the hopper,

Fig. 9 shows a side-view of the drum shown in fig. 8 with a motor for making the drum rotate,

Fig. 10 shows a second embodiment of a drum with carriers for taking out the fibres batch-wise from the fibre supply in the hopper, seen in a first position, and

Fig. 11 shows the same, but in a second position.

Fig. 1 shows a conventional concrete mixer being supplied with raw materials for the mixing from four superjacent silos which are openable and closable by means of a gate or the like closing mechanism, and being connected to the concrete mixer via pipe conduits, which are indicated in the figure by a dotted line. The silos are, as seen in order of succession from the left, a cement silo 1, an additive silo 2, a water silo 3 and an aggregate silo 4.

When the concrete is to be mixed, the concrete mixer 5 is first supplied with the prescribed amount of aggregates in the form normally of stone and sand from the silo 4, a dry mixing hereby taking place, whereafter the cement from the silo 1 is dosed under continued dry mixing. Finally, additives and water from the silos 2 and 3, respectively, are added, and after wet mixing the entire concrete mixture it is now ready for discharge from the concrete mixer 5.

It is usually rather large amounts of materials which ar added to and mix d in the concret mixer in a very short time during the performance of the above process stages. Compared with these large

amounts of material the addition of .g. plastic fibres to fibre concrete constitutes an infinitesimal fraction which it is difficult to distribute evenly in th concrete mixture merely by batch-wise pouring it manually and at random into the latter, in the way it has previously generally been done.

As mentioned in the introduction to the present specification an addition of plastic fibres is capable of considerably improving the material properties of the finished concrete i.a. by distributing any crack-formations into a finely meshed net of unharmful microcracks. The precondition for optimal exploitation of this effect is, however, precisely that the fibres are distributed very evenly in the concrete mixture. Is this not so, the finished concrete will easily become inhomogeneous. In some areas the concrete will thus not have attained the prescribed improvements of the material properties due to lack of fibres, whereas other areas where the fibres lie too close, have become directly weakened, since the fibres in more or less coherent quantities form interfaces which are incapable of transferring tensile forces in the finished concrete construction.

To improve the mixing, the fibres are advantageously added during the dry mixing, which treats the largest amount of materials, and during which the material still has a comparatively loose and easily workable structure. In the short time available during this mixing, and which lies within the range about 1/4 - 1 1/2 min, it is important that the plastic fibres get into contact with as much of the concrete mixture as possible immediately during the dosing proper if a satisfactorily uniform distribution of the fibres in the mixture is to be achieved. When first the fibres have been worked into the mixture they can as a result of their lightness and relatively large surface only with difficulty be displaced relatively to the far heavier content of stone and sand in the mixture.

To achieve uniform distribution of the fibres in the mixture the fibres are thus according to the invention added in an even and constant flow over a period which, as mentioned, advantageously may span most of the dry mixing period. Thereby all parts of the concrete mixture as a result of the mixing process will little by little pass under the zone in which the fibres fall into the concrete mixer, and in this way at once become intimately distributed throughout the entire concrete mass.

According to the invention this is ahieved by a dosing mechanism and a conveyor, shown in a first embodiment in figs. 2-5. The dosing mechanism consists in this case of four storage hoppers 6a-d having four underlying metering hoppers 7a-d, under which there is again accomodated a belt conveyor 8 ending over a hopper 9 which via a pipe 10 leads down to the concrete mixer 5.

In each storage hopper there are, as can best be seen from figs. 8 and 9, a rotatabl drum 11, being driven by a motor 12 and lying in the cylindrical extension 13 of the lower part of th hopper. This drum is provided with a number of outwardly projecting pegs 14 for drawing out cut fibres from the supply 15, which with its under side rests against the drum, from the storage hopper when the drum 11 is made to rotate by the motor 12. According to the nature of the fibres the pegs may have different shapes. In the example shown they are round, but they may also be blade shaped or be completely replaced by vanes spanning the entire width of the hopper.

The cut fibres which the pegs of the drum thus draw out from the storage hopper fall into the metering hopper 7a-d, which is equipped with a symbolically indicated weighing mechanism 17a-d for registering how much fibre cut has fallen into the metering hopper. The weighing mechanism may advantageously be an electronic weighing mechanism automatically cutting off the motor 12 when the storage hopper has been filled with the desired fibre cut portion.

Each metering hopper 7a-d is equipped with an e.g. hydraulically or pneumatically activated gate 18a-d or another closing mechanism which is normally closed. In fig. 2 the gate is open in the storage hopper 7b and its content has fallen in a heap on the conveyor belt 8. The storage hopper 7d has already been emptied and is now ready to be refilled with a fibre cut portion from the storage hopper 6d. The storage hoppers 7a,c have already been filled with fibre cut and are ready for use in the next mixing process.

When the fibre heap 8 is to be added to a concrete mixture the conveyor belt 8 is started and the heap is conveyed to the smoothing rakes 19a-b, which in two steps rake or scrape the heap into a thin layer 20 on the belt 8, as shown in fig. 3 and 5. By adjusting the smoothing rakes 19a-b the thickness of the fibre layer 20 is thus adjusted in dependence of the speed of the belt 8, so that the supply of fibre cut to the concrete mixer is stretched over a predetermined period of each mixing cycle. This period may advantageously be chosen as the main part of the dry mixing period. In this way it is ensured that the fibre cut is added evenly and uniformly to the mixture.

Normally the fibre cut is supplied in comparatively large units in the form of bales or boxes, and it may thus be difficult to draw the fibres from the hopper sufficiently evenly and uniformly if the drum 11 is provided with pegs 14 over the entire width of the hopper. In particular it may cause problems to delimit the quantity which at a given moment is leaving the hopper, when the weighing mechanism 17a-d cuts off the motor 12, so that the metered quantity in the metering hopper 17a-d is not metered with the necessary accuracy. In view of overcoming this drawback the drum 21 is according to the embodiment shown in figs. 10 and 11 only partly provid d with p gs 22 in its axial xtension, whereby the pegs take out a comparatively smaller fibre cut portion for each rotation of th drum.

In this case there is additionally provided a displacement mechanism 23, shown symbolically in the figure as a crank throw, for displacing the drum 21 to and fro so that the fibre supply 15 is successively removed along the entire width of the hopper.

The fibre cut, which rests with its weight against the drum 11;21, may precisely at this point tend to pack, whereby the fibres may be damaged by the pegs during the drawing out, and similarly they may tend to be drawn out of the hopper in coherent lumps which more or less may still stick together also at the dosing into the cement mixture, whereby the fibre lumps may form weak areas in the finished concrete constructions. According to the invention this problem is solved by means of an air cushion which retains the fibres in a loosely floating condition immediately above the drum. For this purpose the drum has been provided with an inner axial cavity 24 which via a number of throughgoing openings 25 communicate with the surroundings. The axial inner cavity 24 of the drum is also connected to a compressed air source (not shown) for blowing, at any rate during fibre take out, an air stream out through the openings 25. Thereby the said air cushion is formed which may further be supplemented with an air flow which via sockets 26 is passed in through the walls of the hopper.

According to the above emdodiment the construction is based on being able to use storages supplied in large units in the form of e.g. bales or boxes. If instead fibre cut is used which is supplied premetered portions, the apparatus may, however, be simplified significantly, as the storage hoppers 6a-d and the weighing mechanisms 17a-d can then be omitted.

According to an uncomplicated and cheap embodiment a storage hopper may be positioned directly above the hopper 9 which via the pipe 10 conducts the fibre cut into the concrete mixer 5. Stretching the fibre supply over e.g. the first dry mixing period is then accomplished by controlling the rotational speed of the drum 11;21. The embodiment shown in fig. 10 and 11 is particularly suited for this purpose, since it is capable by itself of dosing the fibres with great uniformity over a predetermined period of time. For this particularly uncomplicated embodiment there may be used both fibre cut in whole bales or boxes and fibre cut in premetered portions.

Fig. 7 shows a second embodiment which exactly corresponds to the embodiment shown in figs. 2 and 3, apart from the conveyor belt 8 now having been replaced by an air duct 27. The figure shows a fibre cut portion, which has been discharged from the metering hopper 7b, lying at the bottom of the air duct 27. When that portion is to be added to the mixture it is by means of a blower 28 blown through the duct 27 to the concrete mixer 5. On its way the fibre cut must, however, pass a sluice 29, interposed in the air duct 27.

This sluice 29, shown in a larger scale in fig. 7, consists of a rotatable sluice drum 30 having a number of outwardly projecting van s 31 which togeth r with a cylindrical extension 33 of the air duct 27 delimit a number of sluice chambers 32 which each conveys a predetermined volume of fibres through the sluice when the drum rotates. By controlling the rotational speed of the drum the fibre dosing may consequently be stretched evenly and uniformly over e.g. the first dry mixing period. The sluice drum 29 may like the dosing drum 21 be equipped with an axial cavity 34, which via throughgoing openings 35 communicates with the surroundings. The axial cavity 34 is then connected to a compressed air source (not shown) for blowing an air stream out through the openings 35, so that the fibres during the transportation through the sluice are kept in a loose state and prevented from packing or tangling. As shown in fig. 6, the fibre cut may instead of being blown through the air duct 27 be sucked therethrough. In this case the outlet end of the air duct is then connected to the suction side of e.g. a fan.

It is an advantage ot the embodiment shown in fig. 6 with air duct that the air duct may be comparatively long, so that the metering and dosing proper of the fibres may take place in a more remotely situated room, which expediently may also accomodate the supply of fibre cut. To avoid time lags during transportation through the air duct the desired fibre cut portion is therefore premetered and dosed and blown through the duct to the sluice 29, where it is kept in readiness until it is to be added. This dosing is then effected merely by starting the sluice 29.

Claims

1. An apparatus for adding to a concrete mixture a desired quantity of fibre cut e.g. of plastic, and which comprises a concrete mixer, at least one hopper for storing a supply of fibre cut, a dosing mechanism for taking out for each mixing cycle the desired quantity of fibre cut from the said supply, a conveyor for conveying the fibre cut to the concrete mixer as well as a smoothing device for distributing in the course thereof the quantity of fibre cut taken out evenly over a predetermined period of the mixing cycle, **characterized** in that the predetermined period lies within the period of time in which the dry mixing takes place.

2. An apparatus according to claim 1, **characterized** in that the dosing mechanism consists of a rotatable drum positioned at the lower opening of the hopper, the drum being provided with outwardly projecting carriers, such as pegs or blades, distributed along its surface and being adapted for rotating until th d sired fibre cut portion has been taken out from the supply in the hopper.

3. An apparatus according to claim 2, **characterized** in that the drum is only provided with carriers along a limited section of its axial xtension and that at suitable speed it is axially displaceable to and fro in relation to the hopper.

4. An apparatus according to claim 2 and 3, **characterized** in that the drum has an axial cavity with a number of openings leading to the surroundings, and that the cavity via a pipe by a valve is connected to a compressed air source.

5. An apparatus according to one or more of the claims 1-4, **characterized** in that the conveyor is a conveyor belt accomodated under the hoppers and that the smoothing device consists of at least one smoothing rake for distributing the fibre cut portion taken out in a thin layer having a length corresponding to the distance which the belt travels at a given speed during the predetermined period of each mixing cycle.

6. An apparatus according to one or more of the claims 1-4, **characterizing** in that the conveyor is an air duct accomodated under the hoppers, which duct at least by dosing, is blown through by an air stream having sufficient speed for conveying the fibre cut portion taken out through the duct, and that the smoothing device consists of a rotatable sluice interposed in the duct, which sluice comprises a drum with outwardly projecting vanes delimiting a number of sluice chambers, whereby the volume of the latter and the rotational speed of the sluice have been so chosen that the fibre cut portion taken out is distributed evenly over the predetermined period of each mixing cycle.

7. An apparatus according to claim 6, **characterized** in that the drum of the sluice has a cavity with a number of openings leading to the surroundings, and that the cavity via a pipe by a valve is connected to a compressed air source.

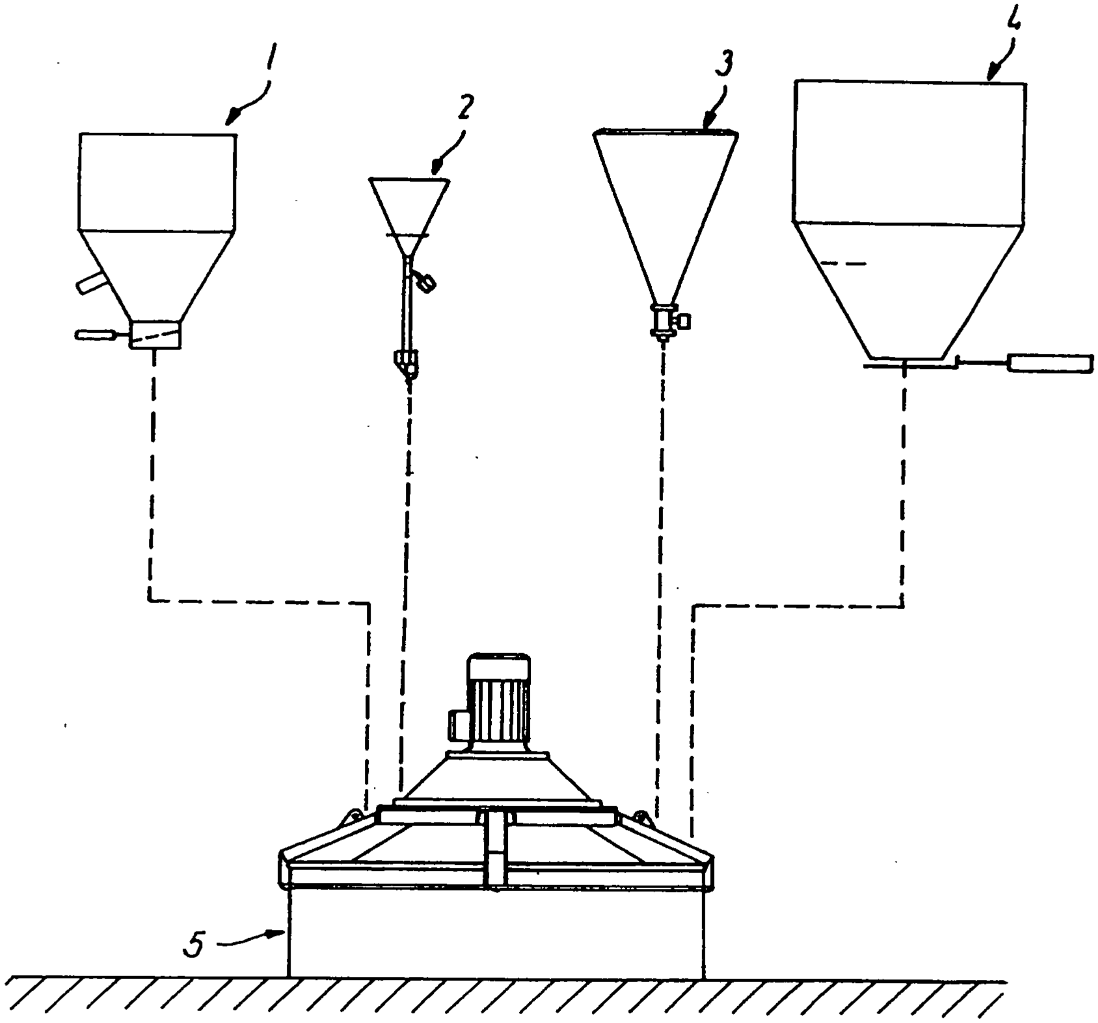
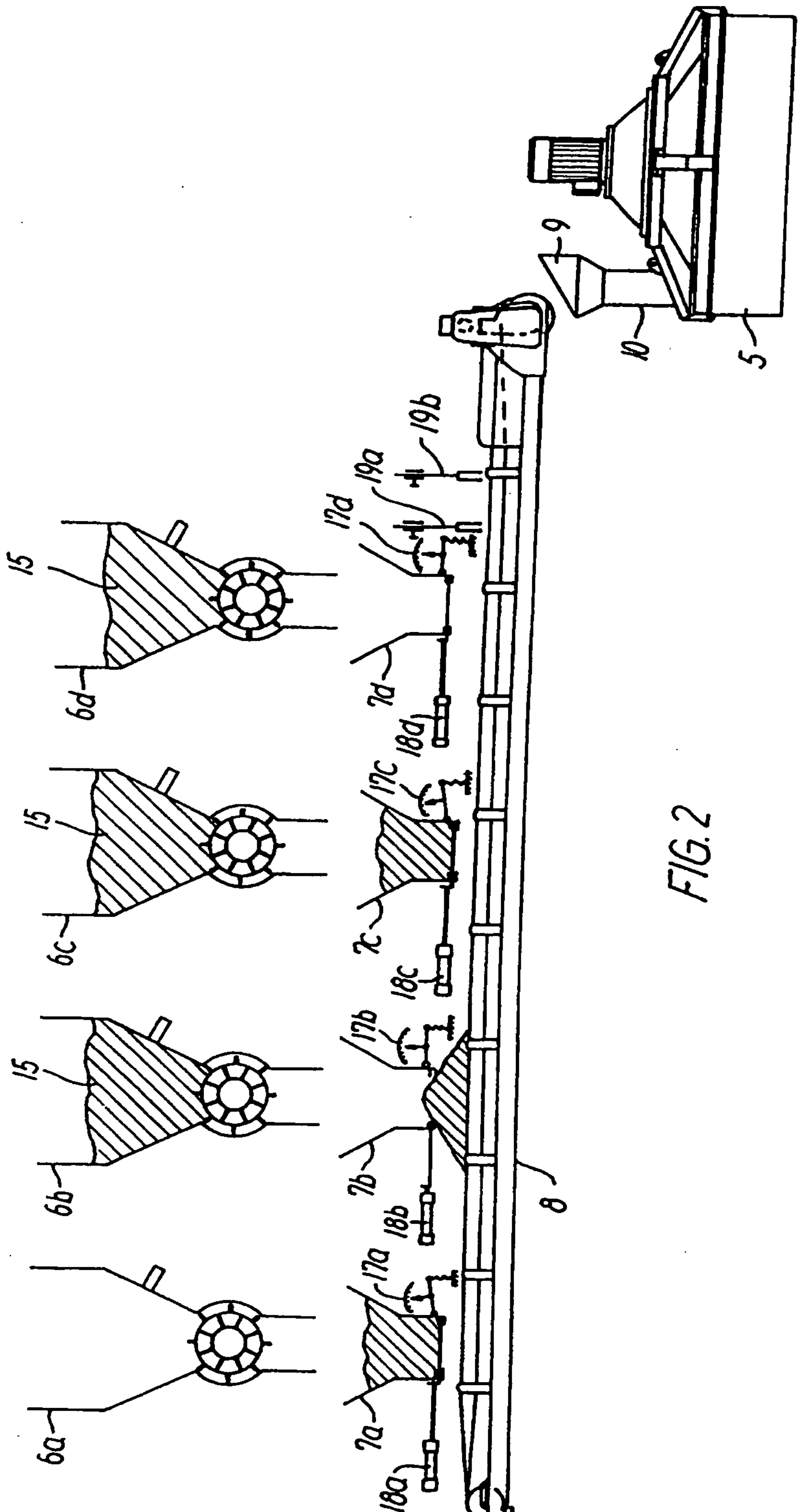


FIG.1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19a
17d
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17c
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8
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FIG. 2

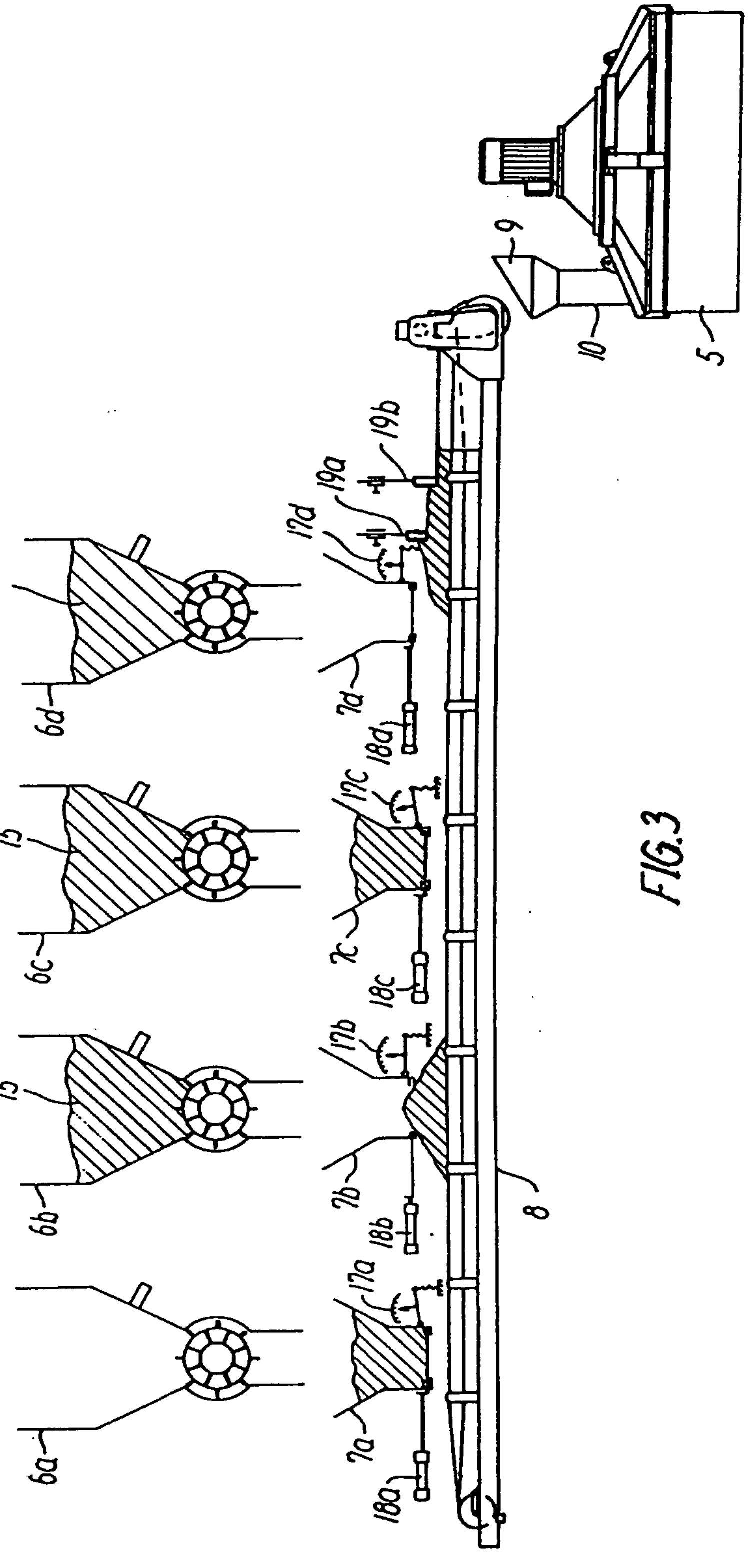
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FIG.3

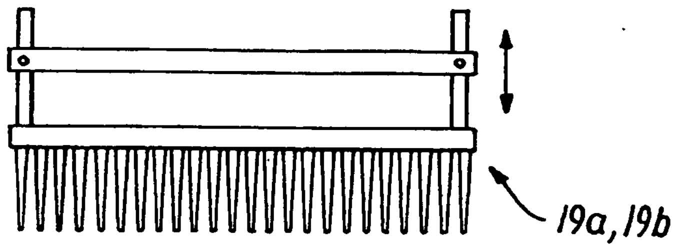

FIG. 4

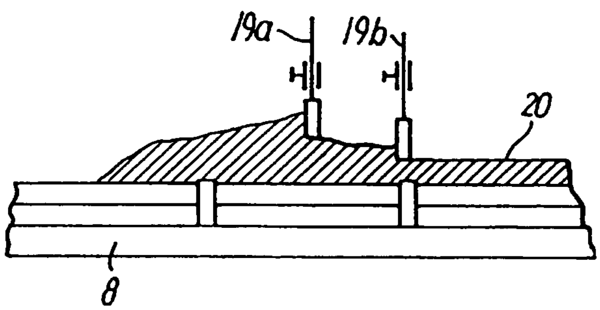

FIG. 5

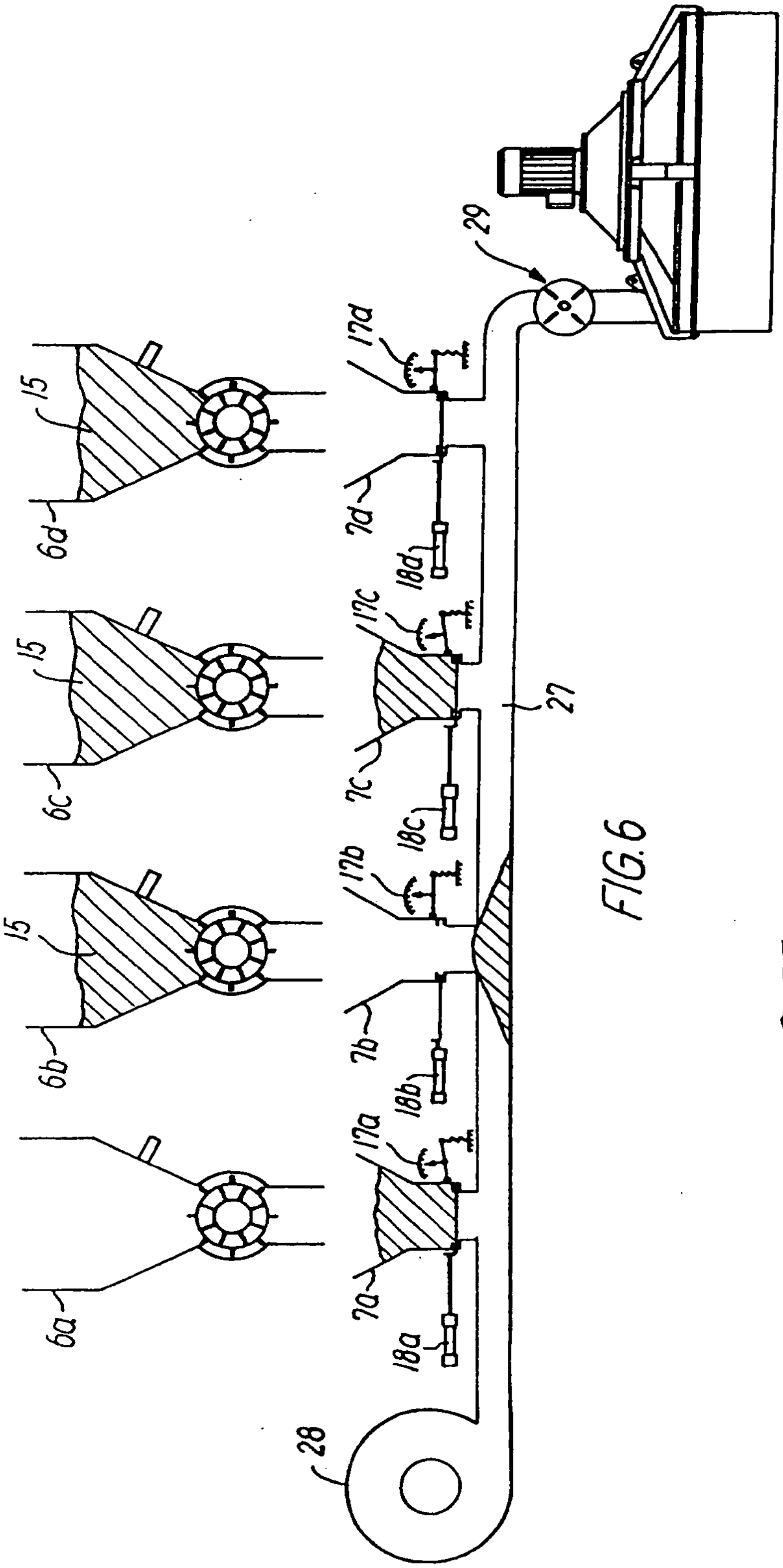
6a
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FIG.6

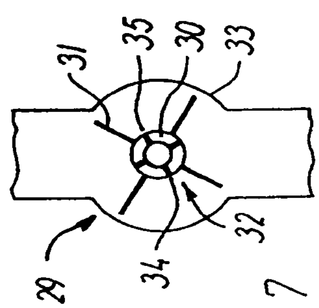
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FIG.7

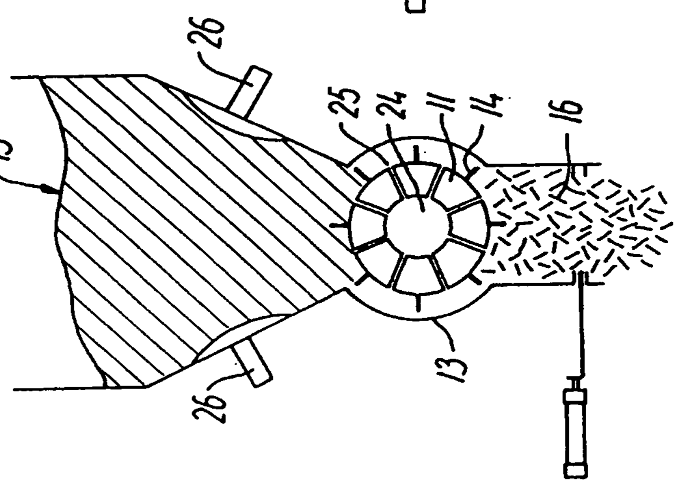

FIG.8

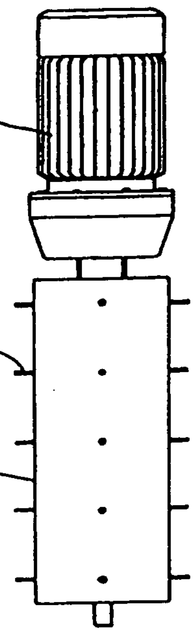

FIG.9

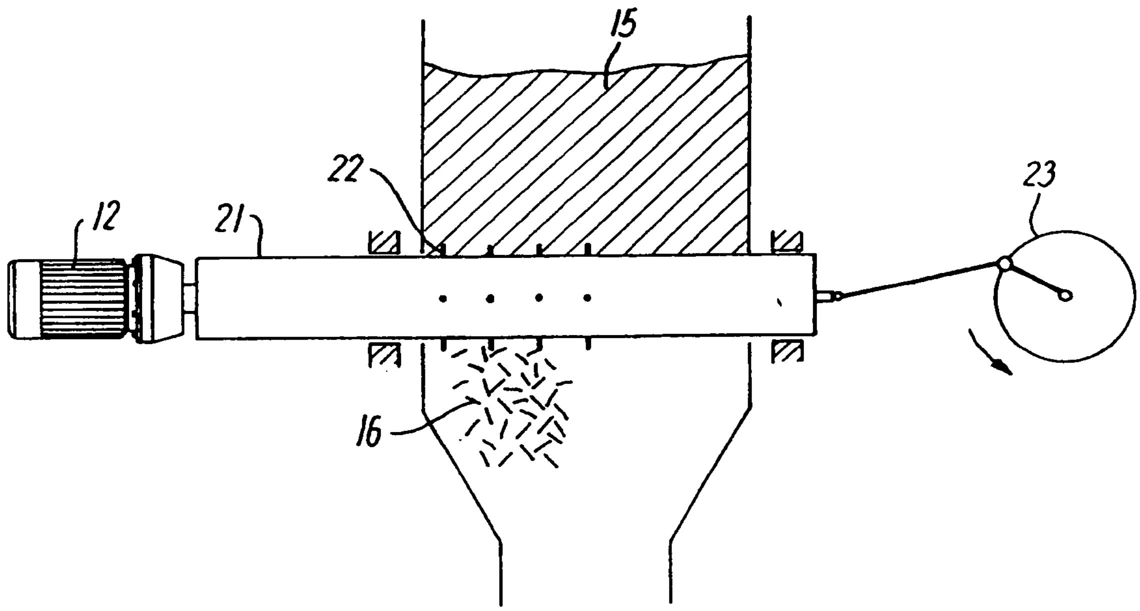

FIG. 10

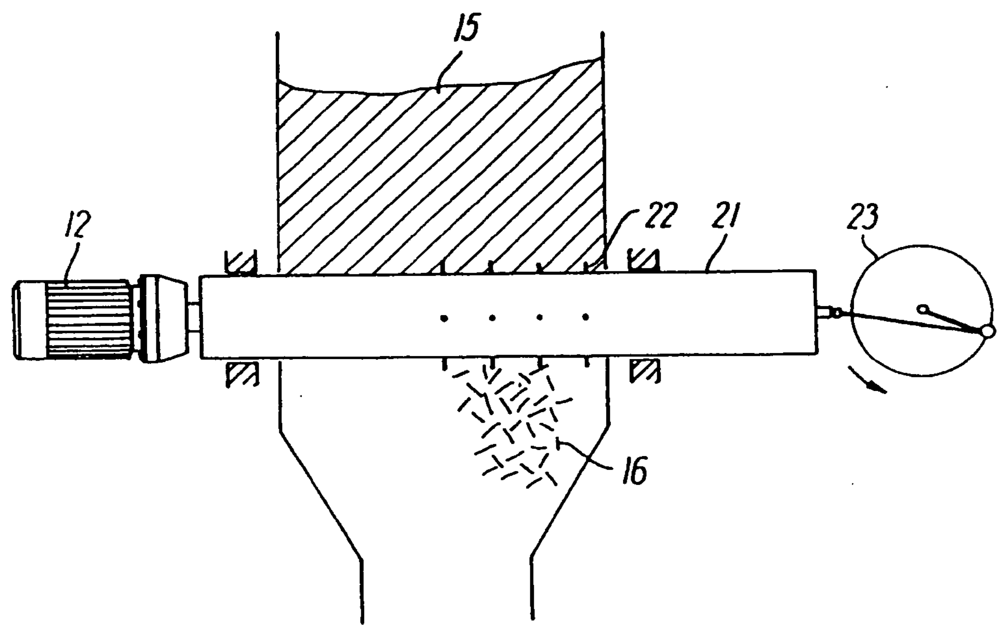

FIG. 11

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 92610010.8

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl5)
Y	CH-A- 460 620 (COMPAGNIE DE SAINT GOBAIN) *Figures 1 and 2* ---	1-4	B 28 C 5/40 B 28 B 1/52
Y	DE-A1-1 584 308 (U. AMMANN, MASCHINEN-FABRIK AG) *Figure 1* ---	1-4	
A	DE-B2-2 613 019 (SUMITOMO METAL INDUSTRIES, LTD.) *Figure 2* ---		
A	CH-A5- 663 568 (ED. ZÜBLIN AKTIENGESELL-SCHAFT) *Figure 2* --- -------		

TECHNICAL FIELDS SEARCHED (Int Cl5)

B 28 B
B 28 C
E 04 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
STOCKHOLM	07-04-1992	JUVONEN V.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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